

Laser in dermatology

Laser

Definition: Laser is an acronym for "Light Amplification by Stimulated Emission of Radiation"

Principle of action: Stimulated emission of radiation

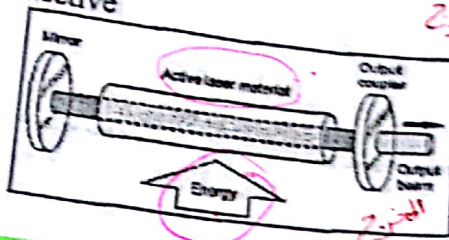
Components of laser apparatus

1. Active medium
2. Source of pumping energy
3. 2 mirrors:

- Totally reflective
- Partially reflective

تقنية
الكهربائية
تعدد (ضوء)

مراية
Silver or gold



Parallel to each other

1st mirror → totally Reflective
2nd mirror → Partially Reflective
المراية فيه مخرج للضوءات
والاخرى عاكسة

2nd mirror → عاكسة للضوء
مراية عاكسة

Properties of laser light:

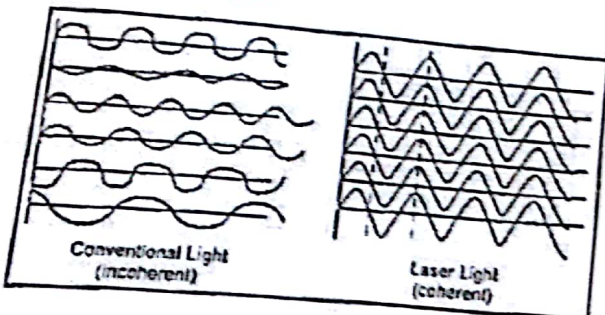
1. **Monochromatic:** single wavelength
2. **Coherent:** highly ordered pattern "in phase"
3. **Collimated:** parallel with a minimal degree of divergence
4. **High power**

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مترابطة

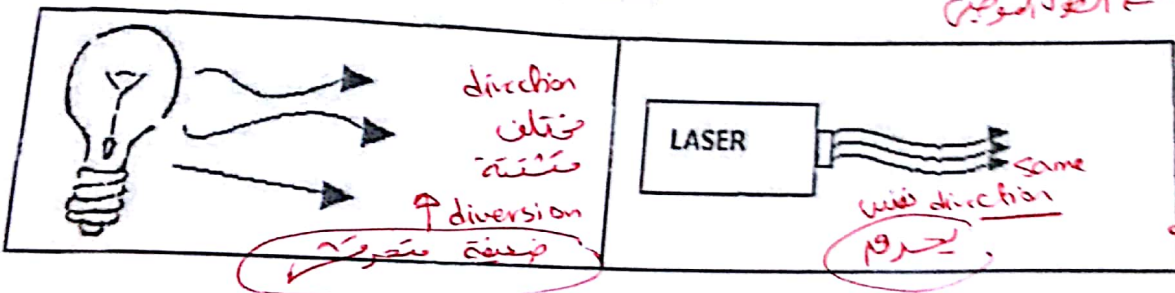
مترابطة

مترابطة

مترابطة



Identical in wavelength
in phase
لها نفس اللون
لها نفس الطول الموجي



Identical in Direction
لها نفس الاتجاه
Parallel
عزمية قوية

identical in phase
قمة الموجة الاولى من نفس الامتد باع قمة اعوجة الثانية

active medium
pumping source

5

Types of lasers:

1. According to active medium:

- Solid-state lasers: KTP (532 nm) – ruby (694 nm) – Alexandrite (755 nm) – Nd:YAG (1064 nm) – Er:YAG (2940 nm)
- Liquid: pulsed dye lasers (585 – 595 nm) *pdl → liquid*
- Gas: CO₂ (10600 nm) – excimer XeCl (308 nm)
- Semiconductor: diode laser

2. According to pumping source:

- Electric discharge
- Optical pumping
- Chemical reaction
- Another laser

3. According to emission spectrum:

- Ultraviolet: excimer
- Visible: ruby – dye
- IR: CO₂ – Nd:YAG – Er:YAG

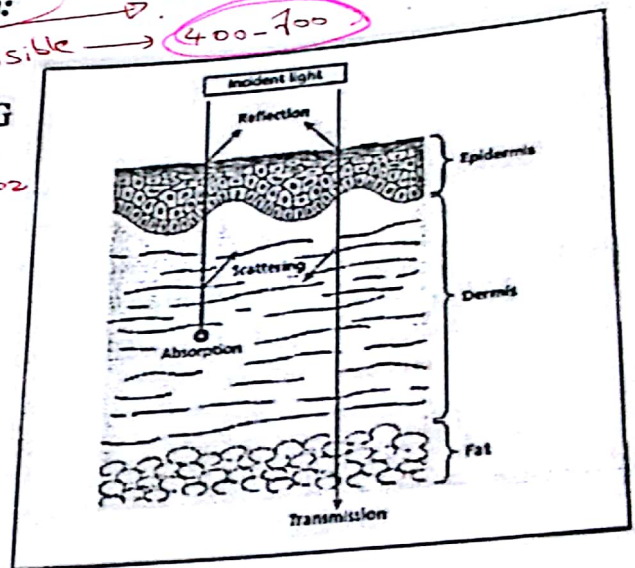
Infrared
7400

4. According to mode:

- Continuous wave (CW)
- Pulsed:
 - ✓ long-pulse (ms)
 - ✓ Q-switched (ns)

5. According to power:

- High power: CO₂
- Low power: diode – He-Ne



Laser-tissue interactions:

- Laser light interacts with the skin in 4 principal ways:

1. Reflection
2. Scattering
3. Transmission
4. Absorption

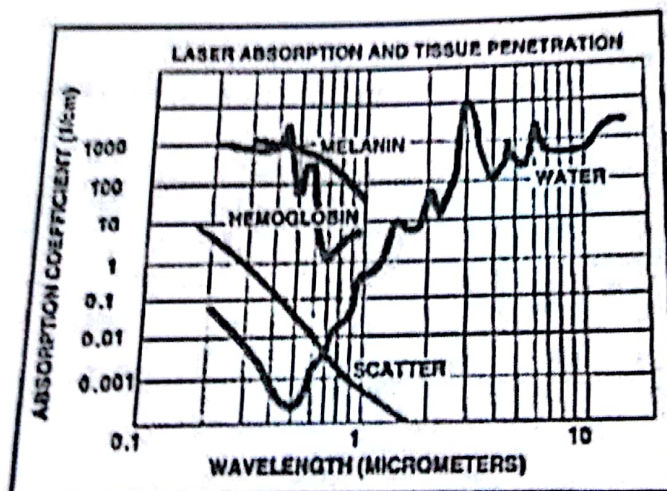
- Tissue effects occur only when light is absorbed

- Reflection, Scattering and Transmission: concerned with laser safety

- When absorption occurs, the laser light transmits its energy to the chromophore leading to:
 1. Photothermal effect: coagulation / vaporization of tissue
 2. Photomechanical (photo-acoustic) effect: tissue disruption by pulsed lasers (pigmented lesions)
 3. Photochemical effect: breakage of chemical bonds or chemical interaction (PDT)
 4. Photobiostimulation effect: tissue stimulation with very low level laser (LLL)

Mechanism of action of lasers in dermatology: "Selective photothermolysis"

- Selective destruction of certain targets in the skin and sparing surrounding structures
- These targets are called "chromophores"
- Each chromophore selectively absorbs light of certain wavelengths "absorption spectrum"
- Selective destruction of certain target necessitate adjustment of 3 laser parameters:
 1. Wavelength
 2. Energy / Power
 3. Pulse duration (in pulsed lasers)
- Important chromophores in skin include:
 1. Hemoglobin
 2. Melanin
 3. Water



Vascular

IPL → vascular

Chromophore	Absorption spectrum	Applications	Lasers used
Hemoglobin	Visible Near IR	Vascular lesions	PDL - KTP - Alexandrite - Diode - Nd:YAG
Melanin	UV Visible Near IR	Pigmented lesions and tattoos	Ruby - KTP - Alexandrite - Diode - Nd:YAG (Q-switched = ns)
		Hair reduction	Ruby - Alexandrite - Diode - Nd:YAG (Long-pulsed = ms)
Water	Mid-Far IR	Skin resurfacing (rejuvenation) Vaporization of epidermal lesions (warts...)	CO ₂ - Er:YAG

Protein

Excimer

dermal vas network

normally melanocytes newly ep cells hair shaft

long pulsed

constitute major component of epidermal dermal

easy to treat

Indications

(A) Therapeutic

1. Vascular lesions: PWS - hemangiomas - telangiectasia - varicose veins
2. Pigmented lesions: (epidermal / dermal / mixed) Lentigens - freckles - melasma - nevi (melanocytic / Ota..)
3. Tattoo removal: decorative / cosmetic / medical / traumatic
4. Hair reduction: hirsutism - hypertrichosis - ...
5. Skin resurfacing (rejuvenation): photodamaged skin (wrinkles) - scars

1. Ablative: CO₂ - Er:YAG

2. Non-ablative: PDL - KTP - Diode → epidermis is intact

6. Vaporization of surface epidermal lesions: warts - SK - AK... (Ablative lasers)

2. Laser-mediated photodynamic therapy → argon, diode

Other indications:

- o Psoriasis - vitiligo (XeCl excimer 308 nm) → AA
- o Hypertrophic scars - keloids - striae distensae (PDL) → CO₂

9. Photobiostimulation: wound healing & pain relief (low-power lasers)

(B) Diagnostic

- o IR-laser confocal microscopy: epidermis and upper dermis can be examined rapidly *in vivo* e.g. skin tumors, scabies
- o Optical coherence tomography (OCT)

Side effects / complications:

1. Pain / Erythema / Edema
2. Post-inflammatory hyper- or hypo-pigmentation (**MOST COMMON**)
3. Scarring / Keloid formation
4. Milia / acneiform eruption / infection (bacterial, viral) in Ablative Skin Resurfacing

Precautions

CO₂
- ERYGNA

Laser hazards and safety

	Hazards	Safety precautions
Beam hazards	<ul style="list-style-type: none"> Fire Skin: thermal burns Eye: ocular damage (retina) 	<ul style="list-style-type: none"> Avoid alcohol - wet drapes Protective clothings Protective goggles
Non-beam hazards	Plume (human papilloma virus - CO ₂ laser vapor)?? Infectivity	Smoke evacuators
		<p>OTHERS:</p> <p>"DANGER" labels</p> <p>Door opens - laser stops</p>

515 → 1200

Intensed Pulsed Light (IPL)

- emits
- ① Polychromatic (multiple wave length)
 - ② non coherent
 - ③ Broad light From 515 to 1200 nm in single double or tripple pulses (2 to 25ms in duration)

• coupling gel is applied to skin before & to

① to epidermal damage

② < Efficiency of light delivery to deeper structures

* chromophores → melanin or Hb

uses: ① vascular lesion → PWS, Haemangiomas, venous lake, angiokeratoma

② hair Reduction →

③ Melasma

④ Active Acne, Rosacea

⑤ freckles

⑥ Rejuvenation

post & instruction

① Apply ice immediately

② Soothing cream

Avoid sun exposure in day (before, after &)

③ if hypo, hyperpigmented →

Resolve within 4-6w

④ eye protection → goggles

S.E.: ① Erythema, oedema, pain

② hyper or hypopigmentation

Sessions every 3-6w

Preoperative

- ① pre R_p:
- ① good medical history
 - ② physical examination → evaluate skin type
 - ③ avoid direct sun exposure or sunburn before R_p
 - ④ oral isotretinoin should be stopped 6m before R_p
 - ⑤ photos before R_p
 - ⑥ prophylactic antiviral agents if patient have history of recent HSV

- ⑦ informed consent
- ⑧ Discuss of expected improvement, potential side effects

② R_p:

- ① on day of R_p → area cleaned, free of make up
- ② Topical anesthetic 1-2h before
- ③ proper eye protection (corneal shield when R_p periorbital area)
- ④ use of smoke evacuators highly recommended in ablative fractional CO₂

- ⑤ R_p at 4 weeks intervals / 4w

- ⑥ outline area to be treated
- ⑦ less aggressive R_p parameters are required for eye lid, periorbital, jawline, neck skin.

③ post R_p:

- ① Ice packs → ↓ pain, oedema
- ② Soothing oint
- ③ Sunblock, avoid direct sun exposure
- ④ Cold water compresses for 10-15 min → 4-6 Times / day during first 2-3 days
- ⑤ avoid Topical exfoliation for at least 4 weeks
- ⑥

Be what you want

Hair Reduction

for laser

① Pre Rx

② Rx

- ↓ fluence in sensitive area
- cooling strategies

③ post Rx

Topical mild antibiotic if CSF Blisters or ulcers
No shaving of treated area for 1-3 days for PIH
hydroquinone